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Art. VI.—*The Readvancement of the Vegetation over the Mined Areas of Bendigo.*

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(With Plates IX. and X.)

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Introduction.

The Bendigo mining field is situated in an area of regularly folded sedimentary rocks of Ordovician age, consisting almost exclusively of sandstones and shales. River gravels of ? Pliocene age occur as hills in one part of the area and Recent alluvium is extensive in many of the valleys. The area is of rather mature topography, the streams are small and the valleys wide. Except for occasional periods of a few days throughout the year, the streams either are dry or consist of a series of pools.

The vegetation consists of a sclerophyllous *Eucalyptus* forest with an abundance of shrubs of various sizes which exhibit xerophilous characters.

Extensive mining operations were carried out in the district up to about sixteen years ago, with the result that the original vegetation has been to a large extent destroyed. It was therefore decided to inquire into the nature of the vegetation that has since invaded the mining field, and to compare it with that of the untouched forests.

I am indebted to Dr. A. H. K. Petrie for his helpful criticism and his untiring interest in this work, and to the late Mr. H. B. Williamson, F.L.S., for the identification of many of the plants.

The Habitat Factors.

A. Climate.

Bendigo is situated 101 miles by rail from the seaboard and has an elevation of 758 feet above sea level. The average annual precipitation over a period of 66 years (1863-1929) is 21·16 inches, and the average temperature of the air over a period of 62 years (1859-1921) is 58·7°F. The mean monthly rainfall and the temperature of the air during these periods are plotted in Fig. 1. It will be seen that, in general, the lowest rainfall periods correspond to the periods of highest temperature and vice versa. Thus the plants receive least water during the time of highest temperatures and with this fact may be associated the presence of many xerophytic types among the vegetation.

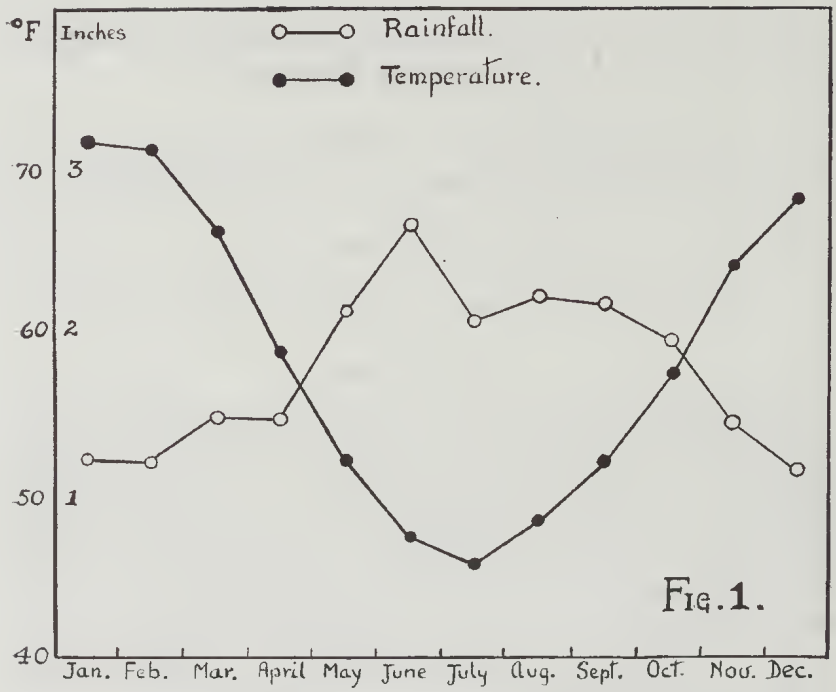


Fig. 1.—Average monthly temperatures determined over a period of 62 years (1859-1921), and average monthly rainfall over a period of 66 years (1863-1929).

The reliability of the rainfall moreover is variable, owing to the fact that droughts are not unknown in the area, and the irregular occurrence of these dry periods cannot be without influence on the type of vegetation that occupies the area.

B. Soil.

The soil types fall into two main groups, namely those formed by the weathering of the original rocks, and those formed by mining operations. These are briefly described below.

(a) Soil formed by the weathering of the original rocks.

The weathering of the Ordovician sedimentary rocks yields varying types of soil. The shales, which contain a fair percentage of iron pyrites, yield a stiff red clay: the sandstones, which unweathered are dark blue-grey, dense rocks, yield a poor hungry soil only a few inches deep. Outcrops of iron-cemented sandstone occur on many hilltops and in such rocky places as these, as we shall see later, *Eucalyptus sideroxylon* finds its home. Intermediate soil types occur where shales and sandstones are closely associated.

Alluvium in the valleys varies from gravelly shingle to yellow loam. The river gravels of ? Pliocene age consist mainly of

rounded quartz pebbles set in a matrix of clayey material, forming a poor soil. In parts this is very porous, and in other parts swampy conditions prevail. Bands of iron-cemented clay form barriers impervious to water, and if these bands occur at or near the surface, swampy conditions arise.

(*b*) *Soil formed by mining operations.*

Deep quartz-mining operations have been responsible for the accumulation of "mullock heaps" and "sludge dumps." "Mullock" is the unwanted material mined along with the quartz. From deep workings it comes to the surface as large pieces of unweathered rock and is deposited in heaps; shallow workings provide partially or completely weathered material, and the debris from such workings dots the area. "Sludge dumps" represent the quartz and country rock which has been crushed in the mine batteries. This is spread over large areas in the form of a thin watery suspension of fine rock particles. Where this contains a large percentage of binding material it forms a permanent "dump" on drying, which is resistant to weathering. Some "sludge dumps" have had a life of 30 years and are little altered at present; but where the amount of binding material is small, the "dump" disintegrates on drying and forms a "sand heap," which is gradually blown away.

The detritus from alluvial mining is heaped up into mounds of greater or less extent. These represent the surface soil from the valleys together with the gravel and other alluvium from the valley floors.

The Natural Vegetation of the District.

The Eucalyptus sideroxylon-Eucalyptus polyanthemos Association.

The vegetation of the non-mined areas, which may be regarded as the original and natural vegetation of the district, consists of an open sclerophyllous *Eucalyptus* forest. This forest represents a single association, dominated by *Eucalyptus sideroxylon, E. polyanthemos* and *E. macrorrhyncha;* the community has been designated by the first two of these names.

The forest is constructed of three strata: these are the tree-stratum, varying in height from 10 to 30 feet, and consisting of *Eucalyptus* spp. alone; a shrub stratum of from 3 to 10 feet in height; and a ground stratum.

The three dominant trees occur commonly together in varying proportions and occupy all soil types; they also occur individually as consociations. Other species, viz. *E. leucoxylon, E. hemiphloia, E. elaeophora, E. viridis,* and *E. rostrata* are found in various localities as subordinates, but have not been observed to form consociations.

The Floristic Composition of the Association.

The species occurring in the tree stratum have been mentioned above, and a further, more detailed account of these will be given later. The floristic composition of the remaining strata is given below in Column A., with the frequency of the constituent species denoted by the following symbols:

a = abundant
f = frequent
o = occasional
r = rare
vr = very rare
l = local

Shrub Stratum.

	A	B	C
Acacia armata	vr	r	f
Acacia aspera	r	r	f
Acacia diffusa	o	o-r	o
Acacia leprosa	r	r	—
Acacia obliqua	r	r	—
Acacia pycnantha	o	f	f
Acacia vomeriformis	vr	vr	—
Astrotricha ledifolia	vr(1)	—	—
Bursaria spinosa	o	r	r
Calytrix tetragona	o	—	—
Cassinia arcuata	a	a	a
Cassinia complanata	o	f	r
Cassytha melantha	r	—	—
Cassytha glabella	r	—	—
Correa rubra	vr	—	—
Daviesia ulicina	o	f	f
Exocarpus cupressiformis	r	vr	r
Goodenia ovata	vr	r	—
Grevillea alpina	o	vr	f
Hakea rugosa	r	vr	r
Helichrysum obcordatum	f	o	o
Humea ozothamnoides	o	f	r
Hybanthus floribundus	vr	—	—
Indigofera australis	vr	—	—
Leucopogon rufus	r	vr	—
Loranthus pendulus	r	—	—
Melaleuca decussata	r	o	f
Persoonia rigida	vr	—	vr
Prostanthera denticulata	vr	—	—
Pultenaea largiflorens	o	o	f
Senecio Cunninghamii	vr	vr	—
Westringia rigida	r	—	—

Ground Stratum.

	A	B	C
Acrotriche serrulata	vr	—	—
Anguillaria dioica	r	r	—
Aristida Behriana	vr	vr	—
Astroloma humifusum	r	vr	o
Brunonia australis	vr	vr	—
Burchardia umbellata	vr	—	—
Calamagrostis filiformis	vr	f	—
Carex pseudocyperus	—	vr	o

Cheiranthera linearis	vr	vr	—	
Crassula Sieberiana	vr	vr	—	
Danthonia pallida	o	o	—	
Danthonia semiannularis	o	o	r	
Danthonia setacea	r	r	—	
Dichopogon fimbriatus	r	vr	—	
Dianella revoluta	r	vr	r	
Diuris maculata	r	—	—	
Drosera glanduligera	o	—	—	
Drosera Menziesii	o	—	—	
Epilobium junceum	vr	r	—	
Eragrostis Brownii	r	r	—	
Eriostemon obovalis	o	vr	o	
Halorrhagis tetragyna	o	f	—	
Hardenbergia monophylla	vr	—	—	
Helichrysum apiculatum	r	vr	r	
Helichrysum bracteatum	vr	vr	—	
Helichrysum semipapposum	vr	—	—	
Hibbertia acicularis	r	vr	o	
Hibbertia stricta	vr	—	o	
Hovea heterophylla	vr	—	—	
Hydrocotyle laxiflora	vr	—	—	
Hypoxis glabella	vr	—	—	
Juncus bufonius	vr	vr	—	
Juncus holoschoenus	vr	r	—	
Juncus pallidus	vr	a	vr	
Juncus pauciflorus	r	f	f	
Juncus polyanthemos	r	f	f	
Juncus prismatocarpus	vr	vr	—	
Kennedya prostrata	vr	—	—	
Leptorrhynchus tenuifolius	vr	—	—	
Loudonia Behrii	vr(1)	—	—	
Melichrus urceolatus	r	r	—	
Orthoceras strictum	vr	vr	—	
Pelargonium Rodneyanum	r	vr	—	
Pimelea humilis	o	—	—	
Poa caespitosa	vr	vr	r	
Pultenaea pedunculata	vr	vr	—	
Rhagodia nutans	vr	vr	—	
Stipa semibarbata	o	f	f	
Stipa variabilis	f	a	a	
Stylidium graminifolium	vr	—	—	
Tetratheca ciliata	r	—	—	
Tetratheca ericifolia	r	—	—	
Themeda triandra	o	r	vr	
Vittadinia australis	vr	o	—	
Wahlenbergia gracilis	o	r	—	

The Eucalyptus sideroxylon Consociation.

The most widespread of the three dominant trees is *Eucalyptus sideroxylon,* which finds its home on the rocky, sparsely soil-covered hills. According to Patton (1), the physical condition of the soil is the controlling factor in the distribution of this tree, it being restricted to well drained soils. However, although well drained soils may be occupied by *E. sideroxylon,* they may also be occupied by consociations of *E. polyanthemos* and *E. macrorrhyncha,* and these trees may occur on all soil types and in all proportions.

The trees of *E. sideroxylon* attain their best development on ridges capped with iron-stone gravel, and in places form a pure forest. Not only does this species occupy the rocky ridges but it may also occupy the alluvium-filled valleys to the exclusion of the other species.

In several parts of this *E. sideroxylon* consociation there may be no other plants present except lichens, the soil conditions presumably being unfavourable for the development of the shrub or ground strata; but in the majority of cases there are representatives of both strata present.

The Eucalyptus polyanthemos Consociation.

Eucalyptus polyanthemos is generally found with *E. sideroxylon* on the hills, but often in the valleys it occurs alone in pure stands, or is accompanied by a number of subordinate species, viz. *E. hemiphloia, E. melliodora, E. leucoxylon, E. elaeophora,* or *E. rostrata,* which occurs along the banks of the larger creeks.

It is generally noticed that when growing on the hills, this tree is of stunted growth, perhaps owing to the porous nature of the soil, but when the valleys are reached, a much more robust tree is developed.

The Eucalyptus macrorrhyncha Consociation.

Although regarded as one of the dominants, this tree is seldom of high frequency of occurrence except where it forms a consociation of its own. It may be a tree of about 25 feet in height, but on rocky quartz-covered hills it may be stunted and attain only about 6 feet in height. In these cases, its growth form approaches that of some of the species of *Eucalyptus* typical of the Victorian Mallee area which are described as "Whipsticks." Such trees have very thin trunks, are of small stature and often have more than one trunk springing from the base.

The Occurrence of Eucalyptus viridis in the Association.

The presence of *E. viridis* in the *Eucalyptus sideroxylon-E. polyanthemos* Association is noteworthy. Typically this tree is found in the Mallee area of Victoria which receives a rainfall of less than 15 inches a year; but it is also found in widely separated areas in northern Victoria which receive a greater rainfall than this. Four miles north of Bendigo is the Borough of Eaglehawk and both on the west and east of this place, *E. viridis* is found in the typical *E. sideroxylon-E. polyanthemos* association. From Eaglehawk there is a belt of country running in a north-easterly direction for about 15 miles known as the "Whipstick Scrub." In this belt are found in association with *E. sideroxylon E. polyanthemos* and *E. macrorrhyncha,* four other species, viz. *E. viridis, E. Behriana, E. polybractea,* and *E. incrassata,* which are prominent constituents of the vegetation

of the Mallee area. The presence of *E. viridis* in the *E. sideroxylon-E. polyanthemos* association was further noticed at a point about 4 miles west of Bendigo and at least 5 miles from Eaglehawk where *E. viridis* begins to become abundant. Thus this Eucalyptus species is seen to have a very wide and a very scattered occurrence.

The Cassinia Society and the Juncus Society.

Within the *Eucalyptus sideroxylon-E. polyanthemos* association, two well defined stratum-societies occur, namely, the *Cassinia* society and the *Juncus* society. The former is a large community and occurs throughout the association, the dominant being *Cassinia arcuata,* a shrub of 3 to 8 feet in height. It comprises all the plants of the shrub and ground strata listed in column A on pages 80-81, with the exception of the *Juncus* species and *Carex pseudocyperus,* which together form the *Juncus* society. The latter community is developed along the creeks, or in places where water lodges during some period of the year.

The Vegetation of the River Gravels at White Hills.

These river gravels form what are known as the White Hills and they give the name to the district in which they occur. They consist of rounded quartz pebbles set in a matrix of white clay which carries varying amounts of iron oxides. This soil is quite different from that of the Ordovician hills, and the possibility that these gravels carried a different flora to that of the general Bendigo area was inquired into.

The gravels were extensively mined for their gold content and now are a source of material for road-making purposes. These operations have almost stripped the area of its vegetation, but here and there remnants exist which give some indication of the former flora. Suckers of *E. sideroxylon* are found and a few stunted trees of *E. macrorrhyncha* and *E. polyanthemos.* The other plants of the area are listed in column C on pages 80-81, and their frequency of occurrence denoted as usual. It will be seen that this vegetation differs very little in composition from that occupying the Ordovician hills, there being only a slight variation in the frequency of the individuals. The hills, however, are so disturbed that this may not be of any real significance.

The Vegetation of the Mined Areas.

Where mining operations occurred, the original vegetation was destroyed over considerable areas in which the bareness and absence of trees now contrasts strikingly with the surrounding forest country. (See Plate XA.)

During the sixteen years that have elapsed since extensive mining operations ceased, however, these once almost bare areas have been invaded by the vegetation of the surrounding forests. Trees are still absent, but several members of the *Cassinia* society, such as the dominant *Cassinia arcuata,* and some grasses, are of general occurrence on the hills; while the *Juncus* society has migrated as a whole and is well developed along the creeks.

The Choice of an Area for Intensive Study.

For the intensive study of the vegetation migrating from the forest into the mined areas, a valley was chosen which runs for about three miles in an almost east-west direction. This tract of country was the scene of concentrated mining activities in the past, especially the ground below the confluence of two creeks which drain the area (the Long Gully and the Ironbark creeks). Here the surface soil has been largely removed by alluvial mining methods. Other portions of the valley are covered with "sludge dumps" and "mullock heaps." Little settlement has taken place, so that a study was able to be made of the egress of the plants from the forest which is found on the western, eastern and, in places, along the northern boundaries.

The Cassinia Society in the Mined Areas.

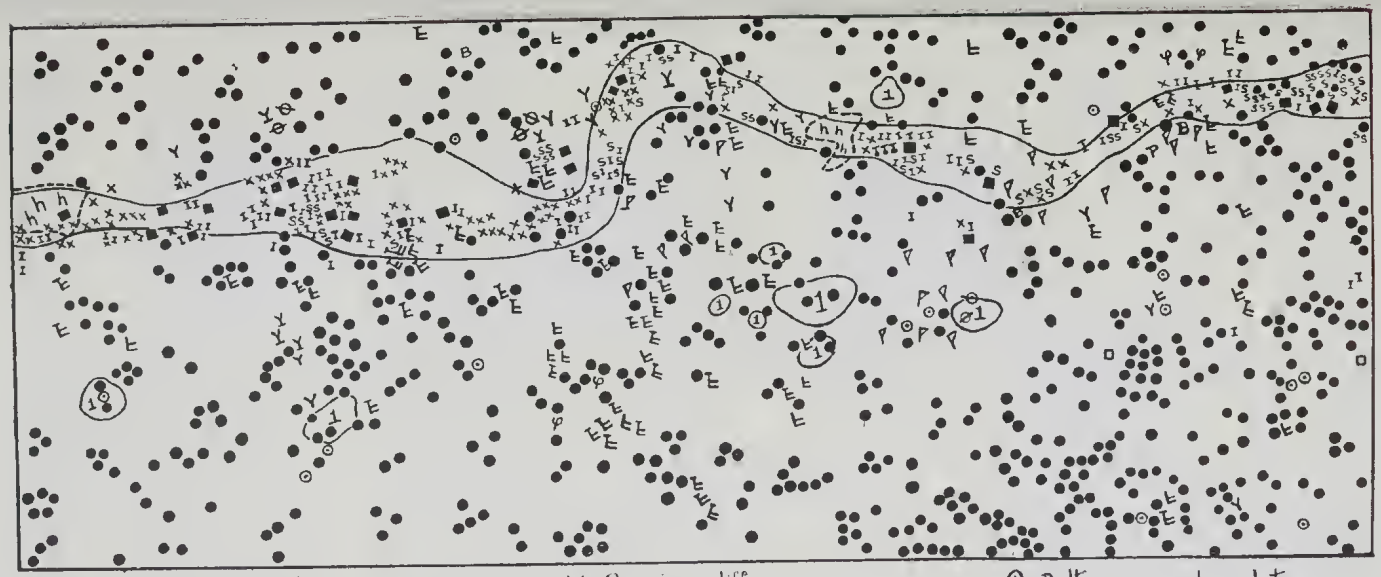
The dominant *Cassinia arcuata* often occupies tracts of country to the almost total exclusion of all other plants except mosses and lichens (*Parmelia* and *Cladonia* spp.), and in parts it forms a closed society of from 6 to 8 feet in height. It is a hardy perennial which bears an enormous quantity of seed, and when in fruit the shrub takes on a light yellow-brown colour which contrasts with the dark dull-green colour of the plant in the vegetative season.

Other members of the *Cassinia* society occurring in the mined areas are found to be distributed spasmodically and these are listed with their frequency of occurrence in column B, on pages 80-81.

Certain of the subordinates of the society are found in considerable abundance in some areas, especially those that fringe the forest. The chief of these are *Acacia pycnantha, Vittadinia australis,* and *Melaleuca decussata.*

1. *Acacia pycnantha.*

Acacia pycnantha is found abundantly in parts of the mined areas fringing the forest and also in partially cleared forest land, where numerous seedlings spring up each year. It is well known that bush fires after having swept an area, will be followed by a vigorous growth of Acacias in their wake. But this pyric factor could not explain the growth and spread of *A. pycnantha* in this area, as no fires have occurred for at least twenty years.



Acacia pycnantha.
A. pycnantha seedling.
Acacia leprosa.
A. leprosa seedling
Acacia armata.
A. armata seedling
Acacia aspera.

Fig. 2.

Acacia diffusa
A diffusa seedling
Bursaria spinosa.
Cassinia arcuata
Daviesia ulicina
Cassinia complanata
Melaleuca decussata

Pultenaea pedunculata
Pultenaea largiflorens
Juncus pallidus
Juncus polyanthemos
Juncus pauciflorus
Juncus prismatocarpus
Juncus holoschoenus

Fig. 2.—Chart of an area along a small creek near the fringe of the forest, illustrating the occurrence of members of the *Juncus* society and the development of *Acacia pycnantha* seedlings near the parent trees.
Scale 3/10 inch = 1 yard.

Fig. 2 is a chart made in mined country fringing the forest where young *A. pycnantha* plants are abundant.

It might be suggested that the turning over of the soil during alluvial mining would give dormant seed the opportunity to germinate. But this area in which the chart was made has lain idle for at least 20 years and young plants still spring up each year; while on the contrary, the stretch of country below the confluence of the Long Gully and the Ironbarks creeks, which was extensively mined (dredged) up to fifteen years ago, shows an almost total absence of *A. pycnantha.*

The localities where *A. pycnantha* plants are abundant are either in or near the forest areas, where other *A. pycnantha* plants are found as normal members of the *Cassinia* society. Seed dispersal in Acacias is brought about by the exploding of the pods, and by this means seeds are thrown a distance of only a few feet; hence the young plants which develop are generally found near the parent tree. (See fig. 2.) Thus it is probable that the sources of spread of this Acacia are the forest areas.

The dormant seeds of *A. pycnantha,* like those of other Acacias, have a hard testa, which is impermeable to water. Under normal conditions, germination does not take place until the seeds have lain dormant for a long period and the testa has decayed sufficiently to allow the entrance of water. Prolific germination at a single particular time is generally brought about by some abnormal factor; such a factor is fire which cracks by heat and so renders them permeable. In the present instance it is suggested that the prolific germination is a consequence of the structure of the vegetation of the mined areas being more open than that of the normal forest. The insolation of exposed seeds, falling on the hard soil, is thus considerably greater than in the forest; and this, with the periodical wetting of the seeds after rain, may render the testas permeable and permit germination to ensue. Other Acacias such as *A. leprosa, A. aspera, A. diffusa,* and *A. vomeriformis,* also show signs of spreading in the mined areas and the areas fringing the forest. In these cases the sources of spreading are probably remnants of the former vegetation, as the present shrubs near which many of the seedlings occur are very old.

2. *Vittadinia australis.*

At the eastern end of the mining field on the river gravels of ? Pliocene age, and to the east and west of these, there is a widespread occurrence of *Vittadinia australis.* This plant is found in situations often devoid of other vegetation, such as sandy and gravelly banks which occur in the creek beds, or which represent the detritus from alluvial mining.

3. *Members of the family Chenopodiaceae.*

To the west of the above river gravels, on stretches of clayey soil, several members of the family *Chenopodiaceae* occur,

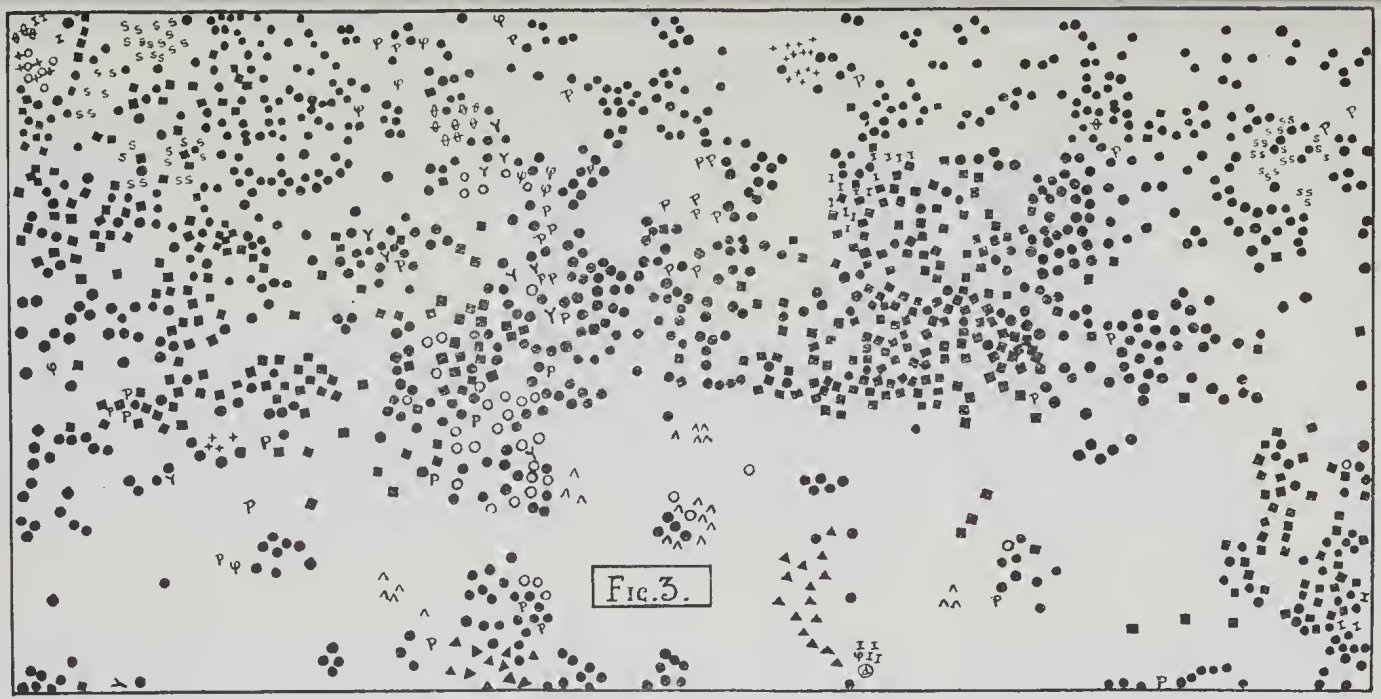


Fig. 3.—Chart of part of an area of about two acres in extent which shows a remarkable development of *Melaleuca decussata* on the silt accumulated against a barrier on the downslope of a hillside.
Scale $\frac{3}{40}$ inch = 1 yard.

namely, *Salsola Kali, Atriplex semibaccatum, Kochia villosa, Bassia quinquecuspis* and *Enchylaena tomentosa.* The presence of these plants has not been observed in the forest areas.

4. *Melaleuca decussata.*

In fig. 3, an area is plotted which shows an abundance of *Melaleuca decussata.* In the forest areas this plant occurs only rarely and developed in small local societies; it appears to be confined to situations which are moist or swampy during some period of the year. In the country that has been mined, it is found most usually spreading along the creek bottoms (see fig. 2). In fig. 3 is charted a portion of an area whose total extent is about two acres, and which shows a great development of young *M. decussata* plants. This area receives the drainage of a hillside, and on the silt accumulated against a barrier on the downslope, these plants are quickly developing.

The Juncus Society in the Mined Areas.

In the forest areas, *Juncus* spp. are comparatively rare, occurring only along the creeks or in places which are moist at some time during the year. Here *Juncus polyanthemos* and *J. pauciflorus* are the most common species.

The society flourishes much more abundantly in the treeless mining areas. It fringes the dams which formerly supplied the mines with water; the creek bottoms which have been widened and silted up in such a way as to cause the streams to flow over wider beds than previously, are often solely occupied by the society; and it also occurs in the numerous small depressions which have been formed by mining operations, and which hold water for a short time after rain. The most abundant member of the society in these habitats is *Juncus pallidus,* which forms almost pure communities in the wide, shallow, sandy creek bottoms to the exclusion of the other members with which it is elsewhere associated. It occupies a variety of soil types. It is found on the Ordovician hills where it can receive water only at times when the normal forest vegetation does; it occurs abundantly in the alluvium-filled creek bottoms where again it obtains water only periodically, since normally these creeks are dry altogether for the greater part of the year; and on "sludge dumps" and "sand heaps" it may be the only plant living. It lives throughout the year in all the above mentioned situations.

Under moister conditions this species is accompanied by other members of the society, and in fig. 2 is plotted an area along a small creek, showing their occurrence.

Small shallow depressions which hold water for a week or two after rain, are generally found to support a stunted growth of *Juncus polyanthemos* and *J. pauciflorus.* If the water is permanent, the plants live throughout the year and attain a height of from 2 to 3 feet; but if the water is ephemeral. the plants are found to be small, and they are short-lived.

In dams which periodically become dried up, it is often seen that *J. polyanthemos* has grown to the centre of the depression, and *J. pallidus* forms a fringe of vegetation around the banks. The other members of this society, *J. bufonius, J. prismatocarpus, J. holoschoenus,* and *Carex pseudocyperus,* occur to a limited extent accompanying the above-mentioned species, mainly along the creeks and around the edges of the larger dams.

The Vegetation of the "Mullock Heaps" and "Sludge Dumps."

The description that has just been given applies generally to the whole of the mined areas. There are, however, certain peculiarities in the vegetation of the "mullock heaps" and "sludge dumps" that call for separate mention.

The "mullock heaps" which represent the weathered rock from the shallow workings support the ordinary vegetation of the mined areas; but those composed of unweathered stone, which through the course of time have come to contain some fine material, derived either from the weathering of the rock or from dust blown into them, support the growth only of *Cassinia arcuata* and some grasses such as *Stipa variabilis.* The "sludge dumps" (and "sand heaps") support in most instances a vigorous growth of *Juncus pallidus. Cassinia arcuata,* however, is also found on them along with the following: *Stipa semibarbata, Danthonia setacea, Stipa variabilis, Bassia quinquecuspis, Kochia villosa, Atriplex semibaccatum, Wahlenbergia gracilis, Dichopogon fimbriatus, Cynodon Dactylon* and *Acacia pycnantha.*

Acacia pycnantha was found on one "sludge dump" on the fringe of the forest area quite near the locality of fig. 2. *Cynodon dactylon,* although not observed in the forest, is found on many "sand heaps" where it forms a good sand-binder.

The Recolonization of the Mined Area.

The general composition of the mined areas, apart from the absence of trees, is sufficiently similar to that of the forested areas to indicate that recolonisation is tending towards a redevelopment of the *Eucalyptus sideroxylon-E. polyanthemos* association. It is a matter of interest, however, to gain some knowledge of the order in which the various species have appeared during the period in which the recolonisation has been taking place. The evidence indicates that there is no long succession of seral communities; the *Cassinia* society may in fact be said to have commenced redevelopment directly, although it appears that not all the subordinates have reinvaded the areas at the same rate as the dominant.

A general survey of the mined areas showed that in the central parts, the number of species occurring were few, and that as the fringing forest areas were approached, the number of species increased. This suggested that there was a difference in the time

taken for individual species to invade the mined areas, and that the depth of penetration of any particular species into the mined area would be an indication of its rate of spreading; and the different rates would thus indicate the order of appearance of the species with the readvancement of the vegetation from the forested areas into the mined areas.

The data for the order of appearance of the species from the forest into the mined areas were obtained by taking a series of traverses from the central portions of the mined country to the surrounding forest. From the information gathered from the traverses it was hoped that the frequency of occurrence of the different species and their depth of penetration into the mined areas would be revealed. But it was found that there were residual patches of the former vegetation present in the mined areas, and these patches were the sources for the distribution of their own members; hence the evidence gained in this manner was not conclusive.

The areas fringing the forest were therefore examined for the presence of seedlings. The frequency of occurrence of these seedlings should indicate, to a certain extent, the rate of spread of the various species which were advancing from the forest into the mined country; this evidence, considered with that that obtained from the traverses, was sufficient to establish the order of appearance of the species in the mined areas. This order of appearance is shown below in three groups.

The Order of Appearance of the Species in the Redevelopment of the Vegetation.

Group 1.

(a) Cassinia arcuata and grasses such as Stipa variabilis, Stipa semibarbata, Danthonia pallida, Danthonia semiannularis. These species mainly occupy the hills.
(b) Juncus spp.—mainly J. pallidus at first, but with J. polyanthemos and J. pauciflorus; followed later by J. bufonius, J. prismatocarpus and J. holoschoenus. These are found generally in the creeks and around the dams.
(c) Vittadinia australis.

These plants in Group 1 occupy the major portion of the mined areas, and often occur to the exclusion of all others. Their spread has been rapid and is perhaps due to their types of seed dispersal. *Cassinia* and *Vittadinia* are members of the family *Compositae* and their seed is provided with a pappus by means of which the seed is dispersed by wind. The seeds of the *Juncus* spp. are very small and may be carried either by water or wind.

Group 2.

Acacia pycnantha
Melaleuca decussata
Cassinia complanata
Bursaria spinosa
Humea ozothamnoides
Halorrhagis tetragyna
Daviesia ulicina
Acacia aspera
Acacia obliqua
Acacia vomeriformis
Epilobium junceum
Calamagrostis filiformis

A.—This shows a typical dam formerly supplying a mine (Koch's Pioneer) with water. *Juncus pallidus* is seen growing round the fringes and also along the shallow edges of the dam. In the background is an old "sludge-dump" which has partially disintegrated to the "sand-heap" state and which supports the growth of *Juncus pallidus*.

B.—*Juncus pallidus* is here seen growing on a "sludge-dump" close to the edge of the forest. In the foreground shrinkage cracks are seen in the sludge.